Unified Physics and the Entanglement Nexus of Awareness

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ABSTRACT
An analysis is made of the correlation between internal processes of the neurobiological system, which ostensibly generate the subjective qualia of experiential awareness, and the external environment which is comprised of objective phenomena. We describe a mechanism of vacuum-state correlation of quanta in the neurobiological system with spatially and/or temporally separated systems, resulting in a co-dependency of states. This is evaluated in the context of how strong correlation of the dipole moments (of charge and spin) of residues in biological polymers, such as deoxyribonucleic acid and microtubulin, are involved in the information processing of awareness, particularly memory, and are entangled across spatial and temporal domains (spacetime). Coherent electromagnetic emissions from both water nanostructures and associated biomolecules may modulate the electronic properties and thus behaviors of supramolecular systems, representing a significant signaling and regulatory mechanism functioning in tandem to the strong correlation of the spin and electromagnetic dipoles of polarizable structures in biological macromolecules. Strong coherence across macromolecular structures of the biological system and extension through spacetime via entanglement resolves the binding problem associated with the generation of conscious awareness by the brain, as it is not only the result of supposed computational activity of neuronal networks, but the integration of information from multiple reference frames across the entanglement network of spacetime. The entanglement nexus of spacetime, herein referred to as the unified spacememory network, emerges as a component of some of the recent elaborations of quantum spacetime architecture in the holographic mass solution to quantum gravity and unification. This is taken in consideration with the Susskind-Maldacena conformal field theory holographic equivalence conjecture that demonstrates the correspondence of micro-wormholes of Planck-scale dimension with quantum entanglement, resolving the information loss paradox and providing a physical and ontological explanation for nonlocality observed in quantum behavior. Together, these concepts describe an architecture of spacetime that is built from information and quantum entanglement through a micro-wormhole network. Applying this model of unified physics to the question of consciousness it is shown how the unified spacememory network is pivotal to engendering fundamental characteristics of awareness that are actively utilized in the macromolecular information systems of the biological organism.

Key Words: entanglement, quantum spacetime geometry, microtubulin, consciousness, quantum brain biology, ontology of awareness, memory, spacememory

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Introduction
An approach to the systematic description of consciousness that is fully coherent with the known processes of physics, chemistry, biology, neurology, information theory and other scientific fields has been elusive. This is exemplified in unresolved issues that have failed to reach a consensus explanation in the research community, such as the hard problem, the binding problem and the subjective–objective dichotomy of consciousness science (Chalmers, 1997).

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The predominant paradigm for the explanation of the mechanisms engendering consciousness has been the neurocomputational model—in which the brain is tantamount to a complex computer. In this model it is assumed that at a sufficient level of complexity of the computational networks (consisting of myriad synaptic connections of neurons) a subjective internal experience emerges as a simulacrum of the external objective world, based on sensory inputs of the organism. While there is obviously computational-like behavior within the biomolecular dynamics of the living system, and certainly in the central nervous system of “higher taxa” (i.e. vertebrates versus invertebrates), this is most often correlated with autonomic responses and it is not at all clear how this would result in an internal experience and sentient awareness of the organism.

This is the hard problem of consciousness, we can examine, measure, and delineate all of the information processing events taking place in the subcellular and intracellular networks of the living organism, correlating them to responses and behaviors, but it is challenging to explain how such processes ever give rise to an experiencer that is the receiver and center of such information, in which there is feeling, meaning, and interpretation of experiences.

As such, the neurocomputational model has significant inability to describe some basic and fundamental processes and phenomena of consciousness. One of the major issues involved is that the neurocomputational paradigm is far too simplistic. Attempts to reduce the synapse to a single bit (functioning as the true/false state of Boolean logic), is helpful in some regards, but overlooks the complexity of the biological system and this specific multidimensional structure.

For instance, it is no trivial matter that the dendritic network, from the macrocellular level to the molecular level of the presynaptic active zone and post-synaptic density are highly fractal in its cytological architectonics. Subsynaptic spines are often seen forming, absorbing, and reforming during learning processes (Nimchinsky et al., 2002). This is accomplished through actin polymerization, a macromolecule with a highly fractal architecture, already suggesting a scale-free characteristic of the complexity of the neuron and neuronal synapse in particular, where the general dendritic aborization and anfractuous pattern of the synaptic network is recapitulated at subcellular scales, and again at macromolecular scales. The actin polymers giving rise to the subsynaptic (and synaptic) structures are attached to a highly anfractuous macromolecule—the microtubule system, found branching throughout the entire cellular cytoplasm, connecting various organelles and membrane structures. Again, generally recapitulating at the macromolecular level the form and pattern found at larger cellular and tissue-level scales.

Note that this complexity of structure is not directly encoded in the genetic machinery, as the proverbial “blueprint”, but instead arises through epigenesis. Fractal morphologies are often a natural result of such non-deterministic epigenesis because structure is formed following unpredictable behaviors and emergent self-organizing dynamics. Such chaos dynamics, as they are known (systems with extreme sensitivity to perturbative influences) represent a prime domain where non-random influences can have significantly large effects—shaping the outcome of what is otherwise a largely unpredictable process. In this way, the processes that are so complex they are unpredictable are not completely random but are subject to influence from the entire environment and all interacting parts. At the subatomic to molecular scales this influence towards non-random behavior can be affected by the entanglement nexus of spacememory—an intrinsically nonlocal field. This vital point will be elaborated further in the discussion.

The scale-free complexity associated with the biological system in general, and the neuron in particular, means that within each cell there is a veritable macromolecular brain, at least in terms of structural complexity, and perhaps to a certain degree functional complexity as well – a fractal hierarchy. Note that the scale invariant nature of information processing as a general feature of physical systems in the universe has been delineated as a critical component of the role of consciousness in the natural physical dynamics of the universe as a whole (Meijer and Geesink, 2017).

This means that the extremely simplistic view of the synapse as a single logic gate or digital bit is misrepresenting the reality of the situation—as such, if we were to utilize the parlance of the neurocomputational model, each “computational unit” contains a veritable macromolecular brain.
within it. There is no computer or human technology yet equivalent to this. Note as well that there is no mechanistic description of how the interaction of millions to billions of synapses produces an agent of awareness—the aware “self” that is the experiencer of sensory and experiential phenomenology.

The activity of synapses and action potentials are strongly correlated with brain processes, and therefore obviously involved with perceptive phenomena, but the how has not been adequately delineated. Such as, how does a “self” that perceives the sensory information generated by the brain emerge from electrical activity of the neuronal network? Problems in this arena are known under such monikers as the ‘hard problem’, ‘the binding problem’, and Cartesian duality, or as referred to herein the ‘subjective–objective dichotomy’ of consciousness science. We make the argument that the electrical activity, generating spatiotemporal electromagnetic fields, are more akin to an antenna that tunes the brain-body system to information exchange with the spacememory network—the ubiquitous field of nonlocal interactions that naturally contains consciousness as an integral element of the information processes engendering the physical properties of the universe. In this way, the question of the origin of consciousness is in fact an exploration of the fundamental nature of the fabric of reality.

When the complexity of the organism is considered from the large-scale tissue structure down to the macromolecular organization of the cell, it becomes suggestive that this fractal organizational hierarchy, with fractal resonances from the molecular to the tissue scale (Ghosh et al., 2014), exhibits massive parallelism in its neuronal functional operations. This massive parallel processing makes the brain essentially analogous to a quantum computer, and it may be literally the case when considering potential quantum entanglement of the supramolecular assemblies of the cell.

As such, it may be unwarranted to dismiss the macromolecular structures within the cell, and particularly the neuron, as having no correlation with perceptive processes leading to mental activity. Indeed, because these macromolecular structures are at the scale where quantum mechanics is considered to be the predominant model applicable to the physics underlying the general and specific behavior, the more phenomenal behavior associated with nonlocality (Hensen et al., 2015), means that phenomena such as entanglement may be involved in the “binding” process – leading to holistic brain-body function across myriad complex information processing networks, and entanglement of those networks with the environment – the latter resolving issues related to the “subjective/objective dichotomy” of consciousness science.

When evaluated with the salient explanans of unified physics, so that the spacetime geometry of quantum states like entanglement are evaluated, solutions to the binding problem and the Cartesian subjective–objective dichotomy of consciousness science are readily accessible. From this we hope to present a coherent, logical, unified, and naturalistic explanation of consciousness and conscious related phenomena, as well as the relation of awareness to the natural evolution and development of physical systems. The primary postulation that is discussed is that the assumed separation of phenomena external to the experiencer and the putative subjective experience within the experiencer are separate and distinct—we suggest that the biomolecular dynamics that underly subjective experiences are correlated with the larger, external system of which the experiencer is a component. This approach runs in parallel with other models that utilize unified physics to view the nature of consciousness in a new light, such as Integral Relativity Theory; wherein Integral Relativity predicts that the observer and observed are a mutually inclusive consciousness/mind/energy/matter continuum through 2D, 3D, 4D, 5D and nD Hilbert Spaces as full-spectrum domains of correlated existence (Neale, 2018).

When evaluated with the salient explanans of unified physics, so that quantum mechanical phenomena as well as spacetime geometry, particularly of quantum states are evaluated, solutions to the ‘binding problem’ and the Cartesian “subjective–objective dichotomy” of consciousness science are readily accessible. From this we hope to present a coherent, logical, unified, and naturalistic explanation of consciousness and conscious related phenomena, as well as the relation of awareness to the natural evolution and development of physical systems. Additionally, the theoretical tenets within the unified model propounded herein are readily testable (falsifiable). The biomolecules of the living organism are very nearly universally poised at a quantum critical state. By devising an in vitro system with biomolecules at a quantum critical state, using the propensity of the system to chaotically switch
between conductive and insulative states, it is possible to devise an experiment that tests if being coupled with the spacememory field the device can be triggered by conscious intention to enter one of the two states which can then be read. Signal non-locality (Cramer and Herbert, 2014) originating from the entanglement nexus of spacememory therefore acts on chaotic systems where tiny perturbations can result in large-scale outcomes. The hypothesis of nonlocal consciousness can then be tested and subjected to experimental scrutiny and possible falsification. This will have direct applications to strong AI devices and methodologies, as well as human-to-machine technological interfaces.

Evaluating the subjective–objective dichotomy of consciousness science

Prevalent models of consciousness, such as the neurocomputational paradigm, regards perceptual experiential phenomena as being symbolic representations of the external world experienced within a virtual simulacrum generated by the brain. Perceptual experiential phenomena are therefore generated by subjects (observers) and may have little to no actual correspondence with the objects of perception as they exist in actuality. As such, there is a dichotomy established separating the subjective internal experience of consciousness from the objective reality of the external world. Wherein the two domains influence each other only ever indirectly, the former through the physical actions of the conscious entity, and the latter through the brain's interpretation of sensory data (electrical signals) from the external environment. A major challenge to any comprehensive scientific delineation of consciousness is this subjective–objective dichotomy, as subjective qualia cannot be objectively characterized, and therefore are outside of the domain of science, seeming to leave only the objective aspects of experience amenable to scientific investigation.

However, when considering experimental observations, theory, and interpretations of modern physics, the nature of space, time, and mass-energy – the fundamental agents of objective reality – may require a re-evaluation of just what is meant by ‘objective phenomenology’. For instance, within the theory of relativity the Lorentz transformations of non-inertial spacetime frames means that time, distance, length and relativistic mass will be different depending on an object’s motion, which is to say that the frame of reference is relative to the state of the observer. Under these conditions the simultaneity of an event cannot even be absolutely established (there is no preferred frame of reference) as observers in different non-inertial reference frames will record a single event as occurring at different times -- and even with two different times, both observers will be correct. The tenuousness of what is meant by the stipulation of absolute objectivity becomes even more prominent when considering the highly non-classical phenomena observed in the domain of quantum mechanics. Not to mention that it is our consciousness that is subjectively interpreting a state as objective.

A significant challenge facing consciousness science, and therefore science itself since all data are ultimately interpreted by human consciousness, is the supposed dichotomy between an objective external reality and the internal subjective experience of the conscious entity. If all experiences are merely virtual re-creations generated within the synaptic networks of the brain, then we only ever experience a simulacrum of the external environment, never actually experiencing reality as it ostensibly objectively exists. However, an alternative view is emerging when the most advanced developments of scientific understanding are taken into consideration. From unified physics, we see that the communicative and connectivity circuits of micro-spacetime quantum geometry, what we refer to as the unified spacememory network (Haramein et al., 2016a), engenders a starkly different explanation for the phenomenology of experience by the conscious entity as well as the supposed objective–subjective dichotomy of conscious experience.

Previously we described how the unified spacememory network produces the ordering parameters and organizational dynamics, in place of the purely stochastic mechanics of conventional theory, that enables the self-organization of matter/energy leading to the development of complex systems, the epitomical example being the biological system. Since these dynamics are fundamental to the formation of self-order and organizational synergy leading to the biogenesis of the biological system, it is posited that they are still very much an integral characteristic of living matter. The informational influence of the spacememory field is perhaps most evident in the non-classical quantum phenomena of the supra-macromolecular system of the biological organism. Wherein high degrees of coherence and
nonlocal interactions integrate proto-conscious events of the spacetime feedback geometry, leading to the emergence of organized matter and self-aware entities that are connected through the universal spacememory nexus.

Information processing events taking place within the synaptic and subcellular networks of the organism are not only strongly correlated within and across the networks themselves, but correlated with the external environment as well, by virtue of the fact that they are in constant interaction, and it is such interactivity that produces entanglement of states.

This means that quantum critical events within the subcellular macromolecular environments of the organism are connected with “external” events to a much higher degree than would classically be anticipated. Most salient of all, is that “external” events—the supposed objective reality—are influenced by the internal processes of awareness occurring within the organism. To put it another way, the universe “knows” subjective qualia, such as the color blue, through our individual experience of the color blue that is integrated in a gestalt consensus of the qualia within the spacememory network connecting all subjective observers and real physical systems—The Entanglement Nexus of Awareness. In this way putatively subjective qualia have an external objective reality. Recall that within conventional consciousness science the color blue (and any other subjective qualia) is only ever experienced in the virtual re-creation of the world by the brain. Objectively there would be no such thing as the color blue, aside from a particular wavelength of electromagnetic radiation that the brain interprets as “blue”, and as such “blue” is only a symbol within the simulacrum of reality that is experienced through the machinations of the mind. The prediction that emerges from this hypothesis is that supposedly subjective qualia will have a meaningful and measurable influence on external objective events, and therefore objectivity cannot be divorced entirely from subjectivity at all, i.e. the subjective experience of the universe is an intrinsic part of its physical nature and behavior.

Moreover, strong coherence across macromolecular structures of the biological system and extension through spacetime via entanglement resolves the 'hard problem' associated with the generation of conscious awareness by the brain, the so called "problem of experience". As it is not only the result of supposed computational activity of neuronal networks, but the integration of information from multiple reference frames across the entanglement network of spacetime, being distributed nonlocally, such that phenomenal experience and awareness are intrinsic qualities shared across scale from macroscopic systems to the fundamental structures and dynamics of the physical universe.

Following on previous work that demonstrated how the nonlocal interaction of information quanta across spatial and temporal domains enables a memory function of spacetime, with retrocausal “memory” or signal transmission being a primary factor in generic self-organizing dynamics, morphogenesis, and elements of intrinsic consciousness, we further expound on how the spacememory field functions to engender objective/causal informational qualia in physical systems. The intrinsic informational qualia are perceived by the living organism, forming the basis of sensory qualia of consciousness. As the range and detail of sensory qualia expands in the living system, as it evolves to higher orders of functional complexity and synergistic organization, the information is fed-back into the spacememory network, further elaborating the qualitative informational content of physical systems. Accordingly, putatively subjective qualitative characters of consciousness can be objectively evaluated through the causal feed-back/feed-forward effects on physical systems.

It is often presumed that the more phenomenal attributes of quantum theory are not possible within the biological system, because there is too much "noise" as a result of high temperature and rapid dispersion of molecules, and therefore too much interactivity or “measurements” leading to constitutive decoherence. This presumption may be a gross misrepresentation of the actual state of the cell, where there is an extremely high degree of communicability and strong correlation among molecular systems, from the atomically ordered water comprising the cytoplasm to the myriad molecules undergoing specific reactions and interactions synchronized spatiotemporally to an extreme degree of precise orchestration. The naïve view of molecules jostling and bouncing around randomly within the cell is erroneous. There are strong ordering influences that occur in the interfacial layers of water with hydrophilic surfaces of the phospholipid membranes, cytoskeleton, and other biomolecules (Del Giudice et al., 2013), as well...
as ordering dynamics that occur via electromagnetic transmission/reception (photon exchange) and correlative spatial resonance within the molecular network of the cell (Cosic, 2012; Karbowski et al., 2015).

To this end we will address the problematic issue of the stochasticity and uncertainty inherent to the predominant quantum mechanical model known as the Copenhagen Interpretation, and how its intrinsic indeterminism and randomness is deficient in describing the rise of complexity and organization observed in physical systems. Quantum mechanical models that employ realism and determinism will be emphasized, such as the De Broglie–Bohm Pilot Wave theory, which utilizes fluid dynamical descriptions of actual waves in space to describe the behavior of quanta. This lends great insight into understanding how phenomenal quantum mechanical behavior, such as strong coherence, entanglement, tunneling, ballistic conduction, etc… is utilized within the biological system. Finally, applying the solutions of unified physics, wherein relativistic and macroscopic phenomena are unified in the description from quantum-level events to the cosmological-scale, we elaborate on the physics operating in the biological system and in physical systems in general which may be key to engendering fundamental characteristics of awareness to higher-order sentence.

Preliminary Examination of Definitions and Assumptions within Consciousness Science

Perhaps the greatest assumption within consciousness and cognitive science is that awareness arises specifically from the activity, ostensibly computational in nature, of the neuronal tissue of the nervous system of complex animals. On closer examination, however, this basic assumption that has predominated the field of consciousness science as formulated is not encapsulating the whole story – evidence suggests that there is more to it than the action of synaptic networks of neurons. For instance, numerous organisms that do not contain neurons, and much less a central nervous system, are capable of learning, memory, and adaptive behavior; see for instance Gagliano (Gagliano, 2015), demonstrating memory and learning in plants. A striking example of this is manifest in some remarkable behavior documented in single celled organisms, particularly in unicellular eusocial protists such as *Physarum polycephalum*, which have been shown to possess volitional and learning behavior (Nakagaki et al., 2000). Note that *Physarum polycephalum* forms dendritic networks of pseudopodia: lending credence to the postulated importance of fractal self-similarity in physical systems, particularly dendritic connection networks like that seen in cytoskeletons and cellular nervous and circulatory systems, that optimize and maximize information transmission and communication (integration).

Even in some of the smallest of living organisms, such as bacteria, there is directional behavior demonstrable in orchestrated behavior and communication through such mechanisms as quorum sensing. The obvious argument of course is that these are purely pre-programmed, automatic responses to environmental or internal stimuli, and any resemblance of intelligent behavior is merely a simulacrum or “blind intelligence”. Yet, this same line of reasoning can be, and has been extended to human behavior as well. And although it is maintained by such proponents that human consciousness is illusionary, this is a highly dubious supposition to maintain, and perhaps is sustained as a viable philosophical purview by the absence of an adequate description defining when a system or entity is in fact conscious or aware.

We offer the following defining characteristic of when a system is technically aware or conscious: when a system displays stand-alone volition / goal-oriented behavior.

Stand-alone volition, or goal-oriented behavior is best ascertained when the behavior is unpredictable by an outside agent, and hence is not pre-programmed. Moreover, fully autonomous and independent stand-alone volition will exhibit goal-oriented behavior that is not predictable even from adaptable pre-programming, i.e. there is at least some informational aspect of the system that is non-computational. Notice that this definition does not say anything about the nature or constitution of the system. Indeed, the system could be what we would consider as artificial. This universality of the propensity for awareness regardless of the particular constitution of the system raises another important consideration: the basic elements necessary for the exhibition of awareness, if not for awareness itself.

The following are key elements that are necessary for the exhibition, and possibly the emergence, of awareness (Table 1).

Consider element 1; diversity of parts – a facet of complexity. A primary presumption within the
neurocomputational paradigm of awareness is that when a system is sufficiently complex it surpasses some specific threshold and consciousness emerges, in part, from the intricacy of the system. Indeed, there must be a modicum of complexity, for it is the interaction of diverse constituents of a system that allow for a sensitivity to states or conditions within and outside of the system (part of information processing). However, while this is an important point and a key facet of any emergentist theory, it is important to perhaps give a fuller consideration of the fractal nature of physical systems, in which there is a scale-free invariance of complexity. This is an important element to consider because if it is theorized that consciousness emerges when an information processing system reaches a sufficient level of complexity, what does this mean for emergentism if the complexity of the computational systems is a scale-free invariant characteristic?

Even considering the fundamental unit of information, a Planck voxel – compared to the hadron scale there is a veritable universe within a single proton. Nowhere is this scale-free invariance of complexity (fractality) more evident than in the biological system, where cells can contain a molecular information processing and communication system that is a veritable molecular brain. This is a key element of how unicellular organisms can exhibit learning, memory, and goal-oriented behavior, yet obviously not contain a nervous system comprised of a multicellular network.

The Unified Spacememory Network

It is obvious that the Copenhagen Interpretation cannot be the last word. The universe is filled with subsystems, any one of which can play the role of observer. There is no place in the laws of quantum mechanics for wave function collapse; the only thing that happens is that the overall wave function evolves unitarily and becomes more and more entangled. The universe is an immensely complicated network of entangled subsystems, and only in some approximation can we single out a particular subsystem as THE OBSERVER. – Leonard Susskind (Susskind, 2016).

In previous work (Haramein et al., 2016a), we discussed the quantum geometry of spacetime comprised of discrete quanta at the Planck scale. The extremely large stress-energy tensor of vacuum quanta at this scale results in sufficiently strong gravitational forces that spacetime is highly curved in a multiply-connected geometry at the Planck scale. This quantum wormhole architecture, also known as quantum spacetime foam, which we refer to as the spacememory network, is directly related to the structure and behavior of elementary particles. Following upon the similar idea first espoused by John Archibald Wheeler in his theory of quantum geometrodynamics, particularly “mass without mass”, we find that it is the extremely high energy of quantum vacuum oscillators that curves spacetime at the micro-scale to a singularity, and it is this curvature that appears as physical particles. In the paper Quantum Gravity and the Holographic mass (Haramein, 2013), it is demonstrated how the mass and radius of the proton is a direct result of this fundamental spacetime architecture, and in the recent publication The Electron and the Holographic Mass Solution (Haramein et al., 2016b), this is extended to the electron as well.

Moreover, the multiply connected geometry that arises from this extremely high curvature and fluctuations at the Planck scale results in micro-wormhole connections between elementary particles. As described by Leonard Susskind and Juan Maldacena in their ER=EPR Holographic Correspondence conjecture (Maldacena and Susskind, 2013) for entangled black holes, the micro-wormhole connections between particles may be responsible for producing quantum entanglement, quantum coherence, and other nonlocal phenomena. Since the same spacetime geometry of maximally entangled states is produced in solutions to black holes in general relativity, it is understood that black holes in maximally extended spacetime may have the same ‘Einstein-Rosen bridge equals Einstein-Podolsky-Rosen correlations’ (ER=EPR) conjecture, a result that Susskind points out resolves the AMPS firewall of the information paradox. Furthermore, this correspondence is highly suggestive that indeed elementary particles are gravitational singularities, or micro-blackholes, and exhibits a type of unification between the relativistic and quantum domains.

When considering the multiply connected geometry of space and time at the fundamental level, and possible memory and hysteresis that arises...
from properties of spacetime analogous to those observed in quantum hydrodynamic analog systems (Bush, 2015) and de Broglie-Bohm pilot wave theory (Mahler, 2016), we refer to this spacetime architecture as *spacememory*.

**Evolutionary development and trans-temporal molecular communication via the spacememory network**

Entanglement occurs across spatially separated spacetime regions or frames (Hensen et al., 2015), as well as temporal frames (Brierley et al., 2015). This means that the fundamental nonlocality, demonstrated by experiments that violate Bell's inequalities, connect systems that are space-like and time-like separated. Because of this fundamental characteristic of nonlocality, space-like and time-like entanglement can be extracted from the quantum vacuum, entangling systems that co-exist temporally but are spatially separated, as well as systems that have never co-existed temporally (Olson and Ralph, 2011; Olson and Ralph, 2012; Megidish et al., 2013). We will investigate what role this nonlocal interactivity of quantum fields – the entanglement nexus – might play in the evolution and development of molecular systems.

A particularly critical domain in which the entanglement nexus may function is in the morphogenetic development of organisms. Although self-organizational dynamics of gene-products, and spatiotemporal regulation through genetic networks, results in emergence of impressive orders of organization, it is perhaps a major deficit of the prevalent evolutionary theory that such convergent complexity emerges through accidents and randomness. While such non-predictable events are certainly a great source of variability – considering the new understandings from the revised and expanded framework of the extended evolutionary synthesis (Pigliucci and Müller, 2010), such as adaptive mutations (Foster, 2000), it may be warranted to posit an organizational element that exhibits some degree of directional control. As will be discussed, this same element engendering proto-sentience to the morphogenetic programs of dynamic systems may be linked to the awareness/intelligence exhibited by living organisms. Nonlocal interaction of the quantum vacuum and all associated quantum fields may be just such an element endowing an intrinsic element of sentience to self-organizing and emergent phenomena of molecular systems.

Consider for example the semi-conservative replication of the deoxyribonucleic acid polymer. A parent strand is retrained with each newly replicated daughter strand, which will produce a chain of entanglement among any lineage of DNA polymers. In this way, each newly formed daughter cell will have its genome entangled with the parent cell, and the same is true of the lineage of gametes in gametogenesis. Mechanisms such as DNA compactification in heterochromatin may serve to help preserve this high degree of entanglement. Not only could this be a significant factor in the coherent coordination of information across multiple cells and tissues of the biological organism, through space-like entanglement, but as well could have significant implications for the evolutionary change of DNA through time-like entanglement.

In the previous publication, *The Unified Spacememory Network* (Haramein et al., 2016a), we described how the emergence of higher orders of organizational synergy in molecular systems will represent a higher degree of spatiotemporal entanglement of such physical systems. Which, through retrocausal interaction across the non-local temporal network, will produce an attractor-like point towards which systems will be influenced to develop (Fig. 1). From this, it is demonstrated how increasing complexity is, at a fundamental level, an expansion of the entanglement network of physical systems.

Considering this, we investigate how adaptive mutations could be influenced or driven by nonlocal influences across the temporal entanglement network. Mutations that lead to phenotypic adaptations that are beneficial for the organism will result in increased survivability, multiplication, and in many cases increased adaptive radiation. This can be seen as an expansion of the entanglement network, within macromolecular structures, such as the DNA polymer, which will result in increased retrocausal interaction – influencing what would otherwise be stochastic changes of the DNA code and resulting phenotype to adaptively beneficial fluctuations.

How specifically would these nonlocal temporal interactions influence the DNA and drive supposed adaptive mutation? Although the mechanisms are probably numerous, we will investigate one such mechanism. Deoxyribonucleic acid is a macromolecular polymer formed from the covalent bonding of deoxypentose nucleic acid
purines and pyrimidines (aromatic heterocyclic organic molecules rich in nitrogen moieties, in which a sugar is linked to a nucleoside). There are two canonical purines and two canonical pyrimidines, referred to as nucleobases, which are covalently bonded together at the phosphate side chain creating a helical filament, or strand. Two such strands come together when complimentary nucleobases align: such that the purine adenine will form hydrogen bonds with the pyrimidine thymine; and the pyrimidine cytosine will form hydrogen bonds with the purine guanine. This is the normal ‘Watson-Crick’ base-pairing structure of DNA, forming a double helix (Watson and Crick, 1953). The heritable information of biological organisms is contained within the base-pairing structure of DNA/RNA.

However, while the canonical nucleobases are certainly the predominant molecular configuration, there is a dynamic equilibrium in which the canonical isomer will interconvert to a less common isoform, or tautomer (Fig. 2) (Singh et al., 2015). This process is called tautomerization, and results when a nonstationary proton within the nucleoside quantum tunnels from a common location to a less-common position within the aromatic ring (Lowdin, 1963). When tautomerization occurs during replication, the DNA sequence will be “misread”, and anomalous base-pairing will occur: such as C* with A, or T* with G (Fig. 3).

Since such quantum tunneling of nonstationary protons of the nucleobases is constantly occurring, the nucleobases can be thought of as existing in a superposition between multiple isoforms. As occurs in decoherence, when DNA ‘interacts’ with the environment, which is to say that when information from the environment is transferred upon the DNA, becoming entangled with its surroundings, it will “collapse” the nucleobase superposition, either as one of the canonical bases, or as a tautomer. Since the bases will be more strongly correlated through the entanglement nexus with sequences that promote greater survivability and adaptation, it will preferentially “select” a tautomer that drives adaptive mutation.

This is one such way that the entanglement nexus will function in natural selection, evolution, and development. Since this nonlocal temporal interactivity will drive self-organizing systems to higher synergetic ordering and convergent complexity, it will be a fundamental characteristic...
Figure 2. Tautomers of (A) adenosine, (B) guanosine, (C) uridine, (D) xanthosine, (E) cytidine, and (F) oxythiamine.

Figure 3. (a) standard base-pairing arrangements of the canonical nucleotide isomers, and (b) anomalous base-pairing arrangements of the tautomers.
of the complex macromolecular systems of the biological organism. As such, it may be an integral mechanism in engendering proto-sentience in self-organizing adaptive systems, expressing increasing levels of awareness within the biological organism (for instance, going from purely perceptual awareness to conceptual awareness). Referring to Table 1; element number 3; we can delineate how the entanglement nexus can function in memory, a key mechanism of awareness. As has been postulated by numerous researchers, and gaining strong empirical and theoretical support, the microtubule network of the cellular ‘cytoskeleton’ has been identified as a key macromolecular structure involved in processing information, engendering or supporting intelligent behavior (adaptive responses), and the utilization of proto-conscious mechanisms of spacetime quantum structure to engender awareness within the biological organism (Hameroff and Penrose, 2014).

Microtubules are long cylindrical supramolecular nanotubes formed from tubulin heterodimer polymers (Fig. 4). The protein tubulin, existing in multiple isotypes each exhibiting different net electric charge, dipole moment, and dipole vector orientation, will form heterodimers such as between alpha and beta tubulin monomers. When a guanosine-triphosphate (GTP) molecule is attached to the tubulin dimers they will polymerize into long helical strands. These helical strands, referred to as protofilaments, will link together to form a hollow tube, comprised of up to 13 or more protofilaments. This creates an interior region, the lumen, that is filled primarily with water and small ions.

As has been demonstrated, the water of the inner core is atomically ordered and is vital to

![Figure 4. A. Schematic representation of tubulin heterodimers and their associated dipole moments. B. Alpha and beta tubulin heterodimers assembled into a protofilament. C. Schematic representation of protofilaments assembled into a microtubule. D. Multiple microtubules bonded together through microtubule associated proteins (MAPs) creating a cellular microtubule network.](image)
the long-range coherence that can be observed in microtubules (Sahu et al., 2013). Furthermore, it has been theorized that the atomically ordered water within the lumen will experience correlated oscillations of its electrical dipole moments, which will stimulate the quantized electromagnetic field resulting in coherent stimulated emission of photons, a process called superradiance and self-induced transparency (Jibu et al., 1994). This quantum optical coherence will result in bio-lasing or laser-like transmission of coherent photons. Such optical signaling has been shown to be possible within microtubules and associated helical mitochondria, where they act as optical waveguides facilitating the transmission of photons (Thar and Kuhl, 2004).

The photons, when absorbed, will modulate the electronic properties of biomolecules, resulting in a direct functional effect. As well coherent interference of cytoplasmic sources will result in holographic information processing; where holographic interference patterns can be stored in the phosphate bilayers of membranes over short time periods, or hard-wired into microtubules and actin filaments. We refer to this as the cellular holographic information processing network. In addition to being a possibly significant source of optical-based coherent information signaling and holographic memory storage, the stimulated photon emissions occur via coupling with the quantum vacuum, in which entangled photons are emitted from the vacuum. This may be an important mechanism in maintaining strong quantum coherence through entanglement, as well as in information transmission through the quantum vacuum – nonlocal spacememory information network.

Concluding Statement

When evaluated with the salient explanans of unified physics, so that quantum mechanical phenomena as well as spacetime geometry—particularly of nonlocal behavior in quantum states—are evaluated, solutions to the ‘binding problem’ and the Cartesian “subjective–objective dichotomy” of consciousness science are readily accessible. From this a naturalistic explanation of consciousness and conscious related phenomena, as well as the relation of awareness to the natural evolution and development of physical systems, is demonstrated. The resulting conclusions of this analysis are that the emergentist model of consciousness is correct only in a limited sense, and because of the nonlocal information exchange across the entanglement nexus of spacememory, there is an intrinsic sentience, awareness, and intelligence in the dynamics of the substantive vacuum structure of space. What emerges is a hybridization between emergentist explanations of consciousness and models of panpsychism. In which it is indeed the complex, intricate, and synergetic structures that emerge within spacememory that generate consciousness, but because they are inherently entangled across space and time, the awareness, sentience, and intelligence is always influencing the dynamics of any one spacetime coordinate, to a greater or lesser degree depending on the exact state of the system in question.

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